REMARKS

Reconsideration and allowance are respectfully requested in light of the above amendments and the following remarks.

Proposed changes to Figs. 1, 3, 6, and 7 are submitted herewith to overcome the objections thereto.

A new Abstract is submitted herewith as required by the Office Action.

A substitute specification is enclosed for the purpose of overcoming the rejection under 35 USC §112, first paragraph. Additionally, a comparison document of the substitute and original specifications is enclosed.

No new matter is believed to be added by the amendments.

Claims 1-10 have been canceled in favor of new claims 11-15, which better define the subject matter Applicants regard as the invention. Support for the features recited in new claims 11-15 is provided by the original claims and Figs. 4 and 7 and their accompanying descriptions in the specification.

Claims 1-10 were rejected, under 35 USC §103(a), as being unpatentable over Esmailzadeh et al. (US 6,175,744) in view of Rom (US 5,450,616). To the extent these rejections are deemed applicable to new claims 11-15, Applicants respectfully traverse.

New claim 11 recites:

A packet communication apparatus comprising:

a transmitter that transmits a plurality of transmission units, constituting a packet signal, in order;

a determiner that makes a determination as to whether or not a quality of a transmitting packet signal has deteriorated below a predetermined quality level, at a communication end, based on transmit power control information received from said communication end; and

a controller that:

in response to a determination by said determiner that the quality of the transmitting packet signal is deteriorated below the predetermined quality level, halts transmit power control on those among the transmission units constituting the transmitting packet signal that are transmitted after the determination; and

based on the transmit power control information on the transmission units constituting the transmitting packet signal, said information received after the determination, performs transmit power control on a beginning transmission unit of a next transmitted packet signal.

The combined teachings of Esmailzadeh and Rom fail to suggest the features recited in claim 11 wherein: (1) in response to a determination by the determiner that the quality of a transmitting packet signal deteriorated below a predetermined quality level, a controller halts transmit power control on those among the transmission units constituting a transmitting packet signal that are transmitted after the determination and (2) based on the transmit power control information, of the transmission units, received after the determination, the controller performs transmit power control on a beginning transmission unit of a next transmitted packet signal.

By contrast to the above-noted claimed features, Esmailzadeh discloses in Figs. 8 and 9 an apparatus for controlling the power of a signal transmitted between a base station and a mobile terminal (Esmailzadeh col. 2, lines 28-31). This apparatus includes a means for detecting a signal fluctuation occurring on a down link or up link; a means for generating power control information in order to compensate for the signal fluctuation occurring on the up link or down link, on the basis of the detected signal fluctuation; a means for compensating for the power of the signal transmitted on the up link or down link on the basis of the information; and a means for: (1) comparing the generated power control information and a predetermined permissible compensated value, (2) temporarily stopping the transmission if the power control information is larger than a predetermined permissible compensation value as a result of the comparison, and (3) compensating for the transmission power if the power control information is equal to or smaller than the predetermined permissible compensation value (col. 2, lines 31-45). Accordingly, when the transmission power of the packet is requested to be more than a predetermined value and when it will be too intense so as to interfere with other base stations or mobile terminals in a mobile communication system, the transmission is temporarily stopped, and a certain time later it resumes (col. 2, lines 47-56).

In short, Esmailzadeh discloses temporarily stopping a transmission when the transmission power of the packet is requested

to be more than a predetermined value (see steps 802A, 802B, 906A, and 906B in Figs. 8 and 9). At some time later, the transmission may resume.

Esmailzadeh does not disclose halting a transmit power control operation for transmission units of a packet that are communicated in response to a determination that a quality of a transmitting packet signal is deteriorated below a predetermined level, as recited in claim 11. A significant distinction between claim 11 and Esmailzadeh, with regard to this feature, is that Esmailzadeh teaches stopping a transmission of data upon determining a deteriorated signal quality, while claim 11 recites continuing the transmission of units of a packet, upon such a condition, but without the benefit of continued transmit power control.

Moreover, Esmailzadeh does not disclose performing transmit power control on a beginning transmission unit of a next transmitted packet based on the transmit power control information of the transmission units received after determining the deteriorated signal quality, as recited in claim 11. As may be determined by inspection of Esmailzadeh's Fig. 8, steps 802-807 disclose that the transmission power is not adjusted after a determination is made that the transmission quality has deteriorated to a particular extent. Instead, the transmission is stopped for the duration of the current slot. When the next slot period arrives, the transmission power remains at the same level that was used prior to determining the

existence of the deteriorated signal quality. No consideration is given to the transmit power control information received after determining the deteriorated signal quality when establishing the transmit power of the next transmission slot. These features are similarly illustrated in steps 906-910 of Esmailzadeh's Fig. 9.

Rom is cited in the Office Action only for teaching the feature of communicating transmit power control information within transmission units (Office Action page 6, last line, through page 7, line 4). However, Rom's proposed teaching does not supplement Esmailzadeh's teachings with regard to the above-noted features distinguishing claim 11 from Esmailzadeh.

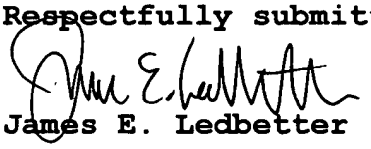
Accordingly, the combined teachings of Esmailzadeh and Rom do not suggest the subject matter defined by claim 11 wherein: (1) in response to a determination that the quality of a transmitting packet signal is deteriorated below a predetermined quality level, a controller halts transmit power control on those among the transmission units constituting a transmitting packet signal that are transmitted after the determination and (2) based on the transmit power control information, of the transmission units, received after the determination, the controller performs transmit power control on a beginning transmission unit of a next transmitted packet signal. Therefore, allowance of claim 11 and all claims dependent therefrom is warranted.

Independent claim 15 recites similar features to those distinguishing apparatus claim 11 from the applied references, but with respect to a method. For similar reasons that these features distinguish claim 11 from the applied references, so too do they distinguish claim 15. Therefore, allowance of claim 15 is warranted.

In view of the above, it is submitted that this application is in condition for allowance and a notice to that effect is respectfully solicited.

If any issues remain which may best be resolved through a telephone communication, the Examiner is requested to telephone the undersigned at the local Washington, D.C. telephone number listed below.

Respectfully submitted,



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DESCRIPTION

PACKET COMMUNICATION APPARATUS AND TRANSMIT POWER CONTROL METHOD

Technical Field

The present invention relates to a packet communication apparatus and transmit power control method used in a radio communication system.

Background Art

It is required in a packet communication for a receiving station to receive a packet or a transmission unit, which is obtained by dividing the packet into portions, transmitted from a transmitting station through a propagation path without data error. Therefore, the transmitting station generally performs error correcting coding per unit transmission portion, and the receiving station performs error detection and error correction per unit transmission portion.

It sometimes happens during the time a packet is transmitted that an error beyond the capability of the error correcting coding occurs on a transmission unit, and therefore cannot be corrected. In such a case, a receiving station abandons the packet, and requests a transmitting station to retransmit the packet.

In order to perform stable communications in the case of performing a packet communication in a radio

communication where a propagation path environment changes rapidly, there is proposed a method in which power control is performed in addition to the above error correcting coding (Japan Laid Open Patent Publication HEI9-233021). The power control is performed in such a way that a quality on a propagation path is estimated from a received signal, and deterioration on the propagation path is corrected corresponding to the estimated quality.

Specifically, a receiving station detects a quality of received signal per packet or unit transmission portion, estimates a propagation path environment based on the received quality, generates power control information corresponding to the propagation path environment, and transmits a signal including the power control information to a transmitting station. The transmitting station adjusts transmit power based on the power control information.

FIG.1 is a schematic view showing a quality of received signal and power control status in a conventional packet communication apparatus when a propagation path quality ~~deteriorates~~is deteriorated for a long ~~term.~~period of time. In FIG.1, reference numeral "1" denotes a transmission packet, and reference numeral "2" denotes a transmission unit. Reference numeral "3" denotes a change in the received quality in a packet receiving station. In FIG.1, "up" indicates that the

transmitting station receives instruction information for a power increase and "eq" indicates that the transmitting station receives instruction information for maintaining power.

When the received quality, i.e., received quality 3 deteriorates on transmission packet 1 or unit transmission portion 2, a transmitting station performs control for increasing transmit power successively a plurality of times. ~~According~~In response to ~~the~~this control, the transmitting station increases the transmit power~~ successively~~, as shown in FIG.1.

However, in such a condition that the control for increasing the transmit power is performed successively, it is considered to happen often that there is an error on a transmission unit received before the transmit power is increased, or an error that cannot be corrected occurs on a transmission unit that is transmitted with increased transmit power, and that retransmission of the packet is needed because the packet is not constructed.

Therefore, although the power control is performed based on a quality of received signal and transmit power is increased, when retransmission of a packet is needed because there is an error on a transmission unit received before the transmit power is increased, or an error that cannot be corrected occurs on a transmission unit, the retransmission of the packet is sometimes unavoidable due to the error on the received unit transmission portion.

Further, increasing the transmit power may increase interference in peripheral communication stations. Accordingly in this case, the power is consumed wastefully, resulting in a problem that an efficient packet communication is not performed.

Disclosure of Invention

It is an object of the present invention to provide ~~an efficient~~ a packet communication apparatus and transmit power control method ~~capable of achieving~~that make possible battery saving ~~without increasing extra~~and reduced interference ~~in~~ against other communication stations.

~~It is a subject matter of~~According to the present invention ~~that~~, when a communication channel ~~condition is poor, power control information is stored without increasing~~ is in deteriorated conditions, the transmit power ~~on~~ of the transmission units in a packet ~~under the poor condition, and the control information is reflected in~~ transmitting ~~a next packet, whereby interference in peripheral communication stations is decreased, the efficiency of the packet communication is~~through this channel will not be increased~~, and total transmit power is decreased, thereby enabling battery saving.~~. Instead, power control information will be saved and this control information will be reflected in the transmission of the next packet, thereby reducing interference against nearby

communication stations, improving the efficiency of the packet communication, and reducing overall transmit power, thus making possible battery saving.

Brief Description of Drawings

FIG.1 is a schematic view showing a quality of received signal and power control status in a conventional packet communication apparatus;

FIG.2 is a block diagram illustrating a configuration of a packet communication apparatus according to a first embodiment of the present invention;

FIG.3 is a schematic view showing a quality of received signal and power control status in the packet communication apparatus according to the above embodiment;

FIG.4 is a flowchart to explain an operation of the packet communication apparatus according to the above embodiment;

FIG.5 is a block diagram illustrating a configuration of a packet communication apparatus according to a second embodiment of the present invention;

FIG.6 is a schematic view showing a quality of received signal and power control status in the packet communication apparatus according to the above embodiment; and

FIG.7 is a flowchart to explain an operation of the packet communication apparatus according to the above

embodiment.

Best Mode for Carrying Out the Invention

Embodiments of the present invention are explained specifically below with reference to accompanying drawings.

~~(First embodiment)~~

~~The first embodiment explains a constitution that a packet undergoing control for increasing transmit power a plurality of times successively is judged to have a high possibility that the packet is retransmitted because the packet has an error that makes it impossible to construct the packet after receiving it, transmit power is thereby not increased on transmission units in the packet after the control is performed the plurality of times, power control information is stored, and that the control information is reflected in transmitting a next packet.~~

The first embodiment will be described with reference to a configuration, whereby a packet that keeps receiving control for increased transmit power a number of times is determined to contain an error that makes restructuring of the packet difficult after reception, and determined to be likely to be retransmitted, and whereby the transmit power of the subsequent transmission units in this packet will not be increased, and, instead, the transmit power control information will be saved and

then reflected in the transmission of the next packet.

FIG.2 is a block diagram illustrating a configuration of a packet communication apparatus according to the first embodiment of the present invention.

A signal transmitted from a communication partner is received at radio reception section 102 through antenna 101. Radio reception section 102 performs ~~on the received signal processing of~~ amplification (gain control), down~~converting~~-conversion and A/D conversion~~.~~ ~~The~~ of the received signal. This A/D converted signal is ~~output~~sent to demodulation section 105, and ~~is~~ demodulated ~~to be~~there and acquired as the received data. The A/D converted signal is ~~further output~~also sent to received quality detecting section 103 and to transmit power information extracting section 106.

Received quality detecting section 103 measures, for example, the SIR (Signal to Interference Ratio) and received power, to detect ~~a~~ the received quality of ~~received~~ the signal. The ~~detected~~detection result of the received quality is ~~output~~sent to determining section 104. Based on ~~the detected~~this detection result, determining section 104 determines whether to increase, maintain or decrease transmit power, and outputs transmit power instruction information to modulation section 108.

Transmit power information extracting section 106 extracts the transmit power instruction information from

the A/D converted signal, and inputs the transmit power instruction information to counter 1071 in transmit power control section 107.

In transmit power control section 107, counter 1071 counts the number of ~~pieces of~~ times transmit power instruction information is input ~~transmit power instruction information. Counting~~. Count control section 1072 in transmit power control section 107 controls transmit power in respect to radio reception section 109 according to the transmit power instruction information, while ~~observing~~monitoring the count number ~~of~~ on counter 1071 ~~to instruct~~and instructing start and halt of transmit power control. Further, ~~counting~~ count control section 1072 ~~performs reset of~~resets counter 1071. Memory 1073 stores transmit power instruction information ~~therein.~~.

Meanwhile, transmission data is ~~output~~sent to modulation section 108 ~~as well as~~ with the transmit power instruction information ~~to be~~, modulated, and then ~~output~~sent to radio transmission section 109. Radio transmission section 109 performs ~~on the modulated signal processing of~~ D/A conversion, up~~converting~~-conversion and amplification (gain control~~). Thus~~) of the modulated signal. The signal processed ~~signal~~ thus is transmitted through antenna 101 as a transmission signal.

An explanation is given of the operation of the packet communication apparatus with the above

configuration.

Radio reception section 102 performs predetermined processing on a received signal, and ~~outputs the resultant~~ sends this signal to transmit power information extracting section 106. Transmit power instruction information extracted in transmit power information extracting section 106 is input to counter 1071 in transmit power control section 107. According to the transmit power instruction information, transmit power control section 107 ~~provides an instruction for increasing~~ instructs radio transmission section 109 to increase or ~~decreasing~~decrease transmit power ~~to radio transmission section 109, while when the section 107 receives the instruction information for increasing the power a predetermined number of times successively, storing the transmit power information in memory 1073 without increasing the transmit power of transmission units in a packet after receiving the information a predetermined number of times, and reflecting the transmit power information collectively at the time of starting transmitting a next packet.~~. When radio transmission section 109 keeps receiving instructions for increased power a number of times, transmit power control section 107 will not increase the transmit power of the subsequent transmission units in a packet but instead store the transmit power information in memory 1073, and reflect the transmit power information, collectively, upon the

transmission of the next packet starts.

Specifically, counter 1071 first counts ~~the number of~~how many times the transmit power instruction information ~~indicative of increasing the~~for increased power ~~is repeated successively. Counting~~continues. Count control section 1072 ~~observes~~monitors whether or not the instruction information for ~~increasing the~~increased power ~~is repeated successively~~continues a ~~predetermined~~certain number of times. For example, the count number of the instruction information for ~~increasing the~~ increased power is compared with a threshold.~~—~~

~~Then, when~~ When transmit power control section 107 detects a situation ~~that~~ where the instruction information for ~~increasing the~~increased power ~~is repeated successively~~continues a ~~predetermined~~certain number of times~~,~~ ~~—~~--for example, when the number of times the instruction information for ~~increasing the power is repeated successively~~increased power continues exceeds a ~~predetermined~~ threshold~~, the~~--transmit power control section 107 ~~does~~will not provide ~~an~~ instruction signal for ~~increasing the~~ increased power to radio transmission section 109 with respect to the subsequent transmission units ~~after the situation, and stores~~in the packet, but instead store the instruction information in memory 1073. After that, ~~at the time of transmitting a~~upon transmission of the next packet, ~~the~~transmit power control section

107 ~~fetches~~ extracts the instruction information stored in memory 1073, and ~~outputs the~~ sends instruction signal to radio transmission section 109 so as to reflect all the instruction information.

Meanwhile, ~~when~~ if the instruction information for ~~increasing the power is not repeated successively a predetermined~~ increased power does not continue a certain number of times, transmit power control section 107 ~~outputs~~ will send the instruction signal for ~~increasing~~ increased or ~~decreasing the~~ decreased power to radio transmission section 109 according to the transmit power instruction information. Radio transmission section 109 adjusts ~~a~~ the gain according to the instruction signal using a gain controller such as an amplifier, ~~and~~ thereby ~~performs~~ performing transmit power control.

~~The~~ This power control is performed as shown in FIG. 3. ~~Packet~~ When packet 201 is divided into a plurality of transmission units 202 ~~to be~~ and these multiple transmission units are transmitted ~~sequentially. When~~ in order, if received quality 203 deteriorates due to ~~a variation in a~~ changes in the propagation path, power control instruction information for ~~increasing~~ increased transmit power ~~is output~~ will be sent under the transmit power control. In FIG. 3, "up" indicates that the transmitting station receives instruction information for increased power, "eq" indicates that the transmitting station receives instruction information for maintaining

power, and "down" indicates that the transmitting station receives instruction information for decreased power. In this case, when the instruction for ~~increasing the power is repeated a predetermined~~increased power continues a certain number of times (four times in FIG.4), ~~the~~ transmit power control ~~is~~ will be halted~~.~~ for the subsequent transmission units. In the case of FIG.3, the last transmission unit is not given transmit power control. In FIG.3, the last unit transmission portion of the packet does not undergo the transmit power control. ~~In this case, the power control instruction information on the last unit transmission portion of the packet is stored in the memory, and is reflected in the transmit power control on a beginning unit transmission portion of a next pocket. Proper transmit power control is thereby~~

That is, in FIG.3, even if the instruction information for increased power is received for a fifth time, the last unit transmission portion of the packet that is going to be transmitted next will not be given transmit power control. In this case, the power control instruction information for the last transmission unit in the packet is stored in memory, and reflected in the transmit power control on the beginning transmission unit of the next packet. By this means, adequate transmit power control will be performed ~~starting~~ from ~~a~~the next packet signal~~.~~ forward. It is therefore possible to

perform efficient communications while decreasing interference in other stations.

The transmit power control method as described above is next explained using a flowchart in FIG.4.

~~At~~ In step (hereinafter ~~abbreviated as ST~~"ST") 301, power control instruction information is extracted from a received signal. ~~At~~ ST302~~, it is judged that~~ determines whether or not a flag is set ~~indicative of~~indicating that ~~the power control instruction information is repeated successively a predetermined number of times.~~

~~When the flag is not set, it is judged that the~~ this power control instruction information ~~is indicative of increasing power and that the power increasing instruction is repeated successively a predetermined number of times (ST303).~~has continued a certain number of times.

When this flag is not set, determinations are made as to whether the power control instruction information is for increased power and whether that instruction for increased power continues a certain number of times (ST303). When the power increasing instruction ~~is repeated successively a predetermined~~continues a certain number of times, the flag is set (ST304~~), while when~~). When the power increasing instruction ~~is~~does not repeat~~ed successively~~ a ~~predetermined~~certain number of times, ~~the~~ power control is performed according to the power control

instruction information (ST307). Further, when the flag is set, the power control instruction information is stored in the memory (ST305), and the power control is halted (ST306).

When the power increasing instruction ~~is repeated successively~~continues a ~~predetermined~~certain number of times, the power control instruction information is stored in the memory (ST305), and the power control is halted (ST306). Then, the power control instruction information stored in the memory is reflected in the transmit power control ~~on a~~ of the beginning ~~unit~~ transmission ~~portion~~ unit of ~~a~~the next packet.

~~A~~The situation ~~that the~~ where control for ~~increasing~~increased transmit power ~~is repeated successively~~continues indicates ~~that~~ a ~~condition is continued that increasing the transmit power does not sufficiently compensate for deterioration of a~~situation where deteriorating received signal quality due to propagation path degradation~~,~~ is not compensated enough. In this case, it is ~~considered~~likely that the transmission units are not received accurately~~,~~ and ~~that a possibility that a~~ the packet ~~is eventually~~will be later retransmitted ~~is high.~~.

According to the transmit power control method of this embodiment, ~~successive pieces of~~continuous power control instruction information ~~are~~ is counted, and, when ~~the~~ control information for ~~increasing the~~increased power

~~is repeated successively~~continues a ~~predetermined~~certain number of times or more, the power control is halted and the power control information is ~~only stored, whereby it is possible to suppress~~stored, thereby minimizing wasteful power consumption by not increasing the transmit power. Further, the stored power control instruction information is reflected in a transmission unit of ~~a~~ the next slot, thereby ~~enabling the packet to be transmitted assuredly.~~making possible secure packet transmission.

Furthermore, since transmission is not performed ~~with unreasonable~~applying unreasonably high power ~~on~~to a poor--quality communication channel, it is possible to reduce interference in ~~peripheral~~nearby communication stations, increase the efficiency of ~~the~~ packet communication, and decrease ~~the total~~overall transmit power, and achieve battery saving.

(Second embodiment)

~~The second embodiment explains a constitution that with respect to a packet undergoing control for increasing transmit power a plurality of times successively, the transmit power of only a pilot signal portion for use by a receiving side in determining a quality of received signal is increased in unit transmission portion of the slot after the control is repeated the plurality of times, and that the transmit power of a last pilot signal portion is reflected in whole transmission units at the time of~~

~~transmitting a next slot.~~A second embodiment will be described with reference to a configuration, whereby, when a packet keeps receiving control for increased transmit power a number of times, only those transmission units in the packet that are used in received quality determination at the receiving end will have increased transmit power, and whereby the transmit power of the immediately last pilot signal is reflected upon all transmission units when the next packet is transmitted.

FIG.5 is a block diagram illustrating a configuration of a packet communication apparatus according to the second embodiment of the present invention. In addition, in FIG.5, the same sections as those illustrated in FIG.2 are assigned the same reference numerals as those in FIG.2 to omit detailed explanations thereof.——

In the configuration illustrated in FIG.5, a configuration of transmit power control section 401 is different from a corresponding configuration illustrated in FIG.2. That is, transmit power control section 401 has counter 4011 that counts the number of ~~pieces of transmit~~power instruction information, ~~counting~~ count control section 4012 that controls transmit power on a control channel for transmitting, for example, a pilot signal, and transmit power on a data channel for transmitting data independently to increase or decrease respective power corresponding to the count number ~~of~~

on counter 4011, control channel power control section 4013 that performs power control on the control channel, and data channel power control section 4014 that performs power control on the data channel.

An explanation is given of the operation of the packet communication apparatus with the above configuration.

Radio reception section 102 performs predetermined processing on a received signal, and ~~outputs the resultant~~ sends this signal to transmit power information extracting section 106. Transmit power instruction information extracted in transmit power information extracting section 106 is input to counter 4011 in transmit power control section 401. According to the transmit power instruction information, transmit power control section 401 provides an instruction for increasing or decreasing transmit power on the control channel to radio processing section 109, while. When ~~when the~~transmit power control section 401 ~~receives~~keeps receiving the instruction information for ~~increasing the~~increased power ~~successively~~ a ~~predetermined~~ number of times ~~successively, the~~, transmit power control section 401 ~~does~~will not increase the transmit power of the subsequent transmission units in ~~a~~ the packet ~~on the data channel after receiving the information a predetermined number of times.~~. Then, on the ~~data~~ control channel, the transmit power of ~~a~~the immediately last control signal

~~portion is~~will be reflected in the transmit power of the signal portion of ~~signal portions on~~ the data channel (i.e. data signal portions~~) at~~) when the ~~time~~transmission units of ~~starting transmitting a transmission unit of a~~the next ~~slot.~~ packet starts.

Specifically, counter 4011 counts the number of times the transmit power instruction information ~~indicative of increasing the~~for increased power ~~is repeated successively for~~ continues in the data channel. Count control section ~~4011 observes~~4012 monitors whether or not the instruction information for ~~increasing the~~increased power ~~is repeated successively~~continues a ~~predetermined~~certain number of times. For example, the count number ~~of~~on the instruction information for ~~increasing the~~ increased power is compared with a threshold.~~—~~

Then, when transmit power control section 401 detects a situation ~~that~~ where the instruction information for ~~increasing the~~increased power ~~is repeated successively~~continues a ~~predetermined~~certain number of times~~,~~ --for example, when the number of times the instruction information for ~~increasing the power is repeated successively~~increased power continues exceeds a ~~predetermined~~ threshold~~, the section 401 outputs an~~ --instruction signal for halting ~~the~~ power control ~~on~~with respect to the subsequent transmission units ~~after~~in the ~~situation~~ packet will be sent to data channel power control

section 4014. Data channel power control section 4014 controls radio transmission section 109 so that ~~the~~radio transmission section 109 halts the power control ~~on~~of the subsequent transmission units ~~after the situation on~~of the ~~data channel.~~ packet.

Meanwhile, ~~on~~as for the control channel, control channel power control section 4013 controls radio transmission section 109 so that ~~the~~radio transmission section 109 increases or decreases ~~the~~ power according to the transmit power instruction information. Radio transmission section 109 adjusts ~~a~~ the gain according to the instruction signal using a gain controller such as an amplifier, ~~and~~ thereby ~~performs~~performing transmit power control.

Then, with respect to the control channel, count~~ing~~ control section 4012 instructs radio transmission section 109 to reflect the transmit power of ~~a~~the immediately last control signal ~~portion (for example,~~ (e.g., pilot signal ~~portion~~) in the transmit power of the data signal ~~portions at the time~~ when the transmission of ~~starting transmitting a~~the transmission ~~unit~~units of ~~a~~the next ~~slot.~~ packet starts.

~~The transmit~~This power control is performed as shown in FIG.6. ~~Packet~~ When packet 501 is divided into a plurality of transmission units 502 ~~to be~~and these multiple transmission units are transmitted ~~sequentially. When~~ in order, if received quality 503 deteriorates due

to ~~a variation in a~~ changes in the propagation path, power control instruction information for ~~increasing~~increased transmit power ~~is output~~will be sent under the transmit power control.—

In FIG.6, "up" indicates that the transmitting station receives instruction information for increased power, "eq" indicates that the transmitting station receives instruction information for maintained power, and "down" indicates that the transmitting station receives instruction information for decreased power.

In this case, when the instruction for ~~increasing the power is repeated a predetermined~~increased power continues a certain number of times (four times in FIG.6), ~~the~~ transmit power control ~~is~~ will be halted ~~on data signals.~~for the subsequent transmission units. In the case of FIG.6, the last transmission unit is not given transmit power control. In FIG.6, the last unit transmission portion of the packet does not undergo the transmit power control. That is, in FIG.6, even if the instruction information for increased power is received for a fifth time, the last unit transmission portion of the packet that is going to be transmitted next will not be given transmit power control. Meanwhile, the transmit power control is performed on each ~~unit~~ transmission ~~portion~~ unit of a pilot signal ~~to be transmitted~~ that transmits on the control channel according to the power instruction information. Then, on the data channel, the

transmit power control ~~is performed~~ on ~~a~~ the beginning ~~unit~~ transmission ~~portion~~ unit of ~~a~~ the next packet is performed according to the power instruction information of ~~a~~the immediately last pilot signal. In other words, ~~on a~~with the data signal, ~~an amount denoted with "H" corresponding to~~ the transmit power ~~instruction~~control information of "H," which combines h1 and h2, in FIG. ~~5~~6 is reflected ~~in~~upon the beginning ~~unit~~ transmission ~~portion~~ unit of the next packet.

The transmit power control method as described above is next explained using a flowchart in FIG.7.

~~At~~ In ST 601, power control instruction information is extracted from a received signal. ~~At~~ ST602~~, it is judged that~~ determines whether or not a flag is set ~~indicative of that the~~indicating that this power control instruction information ~~is repeated successively~~has continued a ~~predetermined~~certain number of times.

When ~~the~~this flag is not set, ~~it is judged that~~ determinations are made as to whether the power control instruction information is ~~indicative of increasing~~for increased power and whether that ~~the power increasing~~ instruction ~~is repeated successively~~for increased power continues a ~~predetermined~~certain number of times (ST603). When the flag is set, transmit power control ~~is~~will be performed only ~~on a~~with respect to the pilot signal ~~portion of a~~in the control channel according the power control instruction information (ST605). In other words, the

transmit power control is halted on ~~a~~ the signal potion of the data channel~~.~~ (ST605). With the beginning transmission unit of the next packet, power control for the data signal is performed (ST607).

Further, when the ~~power increasing~~ instruction ~~is repeated successively~~ for increased power continues a ~~predetermined~~certain number of times, the flag is set (ST604), and the transmit power control is performed ~~on~~ only ~~a~~with respect to the pilot signal ~~portion~~ of the control channel according to the power control instruction information (ST605). In other words, the transmit power control is halted on ~~a~~the data signal ~~portion.~~.

When the ~~power increasing~~ instruction ~~is~~for increased power does not ~~repeated successively~~continue a ~~predetermined~~certain number of times, the power control is performed on the data channel and control channel for each unit transmission portion according to the power control instruction information (ST606).~~—~~

~~A~~The situation ~~that the~~ where control for ~~increasing~~increased transmit power ~~is repeated successively~~continues indicates ~~that~~ a ~~condition is continued that increasing the transmit power does not sufficiently compensate for deterioration of a~~situation where deteriorating received signal quality due to propagation path degradation~~.~~ is not compensated enough. In this case, it is ~~considered~~likely that the

transmission units are not received accurately~~,~~ and ~~that a possibility that a~~the packet ~~is eventually~~will be later retransmitted~~ is high.~~.

According to the transmit power control method of this embodiment, ~~successive pieces of~~continuous power control instruction information ~~are~~ is counted, and, when ~~the~~control information for ~~increasing the~~increased power ~~is repeated~~continues a ~~predetermined~~certain number of times or more, the ~~transmit power on a~~pilot signal ~~portion control is only increased,~~ alone will have increased transmit power and the transmit power ~~on a~~of the data signal ~~portion is~~will not be increased. ~~It is thereby possible for the power control to continue to operate accurately between a transmitting station and a receiving station that judges a quality of received signal from the pilot signal portion without forcing the transmitting side to transmit signals with unnecessary high power.~~By this means, it is possible to maintain accurate operation of power control with respect to the receiving station that determines received quality from the pilot signal and prevent transmission applying excessive power. As a result, it is possible to reduce interference in ~~peripheral stations~~the surroundings and increase the efficiency of packet communication. Further, the power control instruction information ~~on a~~for the pilot signal ~~portion~~ is reflected at ~~the time of starting~~upon the power control information for the pilot signal when the transmit

power control ~~on a~~of the data signal ~~portion, whereby it is possible to transmit packets assuredly.~~ starts, thereby securing the transmission of the packet.

~~On~~Thus, on a poor-quality communication channel, ~~thus~~ controlling transmit power of ~~a~~ the pilot signal ~~portion~~ and the data signal ~~portion~~ separately ~~enables~~makes it possible to maintain accurate operation of the power control ~~to continue to operate accurately~~ and ~~further enables~~prevent transmission ~~not to be performed with unreasonable high~~applying excessive power. ~~It~~By this means, it is ~~thereby~~ possible to reduce interference in ~~peripheral~~nearby communication stations, increase the efficiency of packet communication~~s~~, and perform more proper transmit power control ~~in transmitting a~~upon next packet~~.~~ transmission.

The packet communication apparatus according to ~~either of~~ the ~~above~~ first ~~and~~ or second embodiment~~s~~ is applicable to a base station apparatus and a communication terminal apparatus such as a mobile station in a digital radio communication system. ~~It is thereby possible to achieve radio communications with high efficiency without consuming power wastefully.~~ The present invention thus enables radio communications at an excellent level of efficiency at minimum power.

A packet communication apparatus of the present invention adopts a configuration having an extractor that extracts transmit power control information from a packet

signal comprised of transmission units each including the transmit power control information, a determiner that determines quality deterioration of the packet signal, and a controller that performs control for halting transmit power control on a transmission unit to be transmitted after determining the quality deterioration on the packet signal, based on a determined result.

According to this configuration, ~~since~~ the power control is halted and the power control information is ~~only~~ stored when ~~a~~ the quality of the packet signal deteriorates, ~~whereby~~ so that it is possible to ~~suppress~~ minimize wasteful power consumption by not increasing the transmit power.

~~Further~~ Furthermore, since transmission is not performed ~~with unreasonable~~ applying unreasonably high power ~~on~~ to a poor-quality communication channel, it is possible to reduce interference in ~~peripheral~~ nearby communication stations, increase the efficiency of ~~the~~ packet communication, and decrease ~~the total~~ overall transmit power, and achieve battery saving.

A packet communication apparatus of the present invention adopts another configuration having storage that stores the transmit power control information for the unit transmission portion to be transmitted after determining the quality deterioration on the packet signal, where based on the transmit power control information stored in the storage, the controller

performs the transmit power control on a beginning unit transmission portion of a next packet.

According to this configuration, ~~since~~ the stored power control instruction information is reflected ~~in~~upon a transmission unit of ~~a~~ the next pocket, so that it is possible to transmit the packet assuredly. Further, proper transmit power control can be performed ~~starting~~ from ~~a~~the next packet signal. ~~It~~ forward, so that it is ~~therefore~~ possible to perform efficient communication~~s~~ while ~~decreasing~~reducing interference in ~~other stations.~~the surroundings.

A packet communication apparatus of the present invention adopts another configuration having an extractor that extracts transmit power control information from packet signals each comprised of transmission units each including the transmit power control information, the packet signals being transmitted using a data channel and a control channel, a determiner that determines quality deterioration of the packet signals, and a controller that performs control for halting transmit power control on a transmission unit to be transmitted after determining the quality deterioration on a packet signal for the data channel signal, based on a determined result.

According to this configuration, on a poor-quality communication channel, ~~thus~~ controlling transmit power of ~~a~~ the pilot signal ~~portion~~ and the data signal ~~portion~~

separately ~~enables~~makes it possible to maintain accurate operation of the power control ~~to continue to operate accurately~~ and ~~further enables~~prevent transmission ~~not to be performed with unreasonable high~~applying excessive power. ~~It~~By this means, it is ~~thereby~~ possible to reduce interference in ~~peripheral~~nearby communication stations, increase the efficiency of packet communication~~s~~, and perform more proper transmit power control ~~in transmitting a~~upon next packet~~.~~ transmission.

A packet communication apparatus of the present invention adopts another constitution where based on the transmit power control information for a last unit transmission portion of the packet signal on the control channel, the controller performs the transmit power control on a beginning unit transmission portion of a next packet on the data channel.

According to this constitution, the power control instruction information of ~~a~~ the pilot signal ~~portion~~ is reflected ~~at the time of starting the transmit power control on a data signal portion, whereby it is possible to transmit packets assuredly.~~ when the transmit power control of the data signal starts, thereby securing the transmission of the packet.

In the packet communication apparatus of the present invention, it is preferable for the determiner to determine the quality deterioration using the number of times the transmit power control information for

increasing transmit power ~~is repeated successively.~~continues.

A communication terminal apparatus of the present invention is characterized by having the above packet communication apparatus. A base station apparatus of the present invention is characterized by having the above packet communication apparatus. ~~According to these constitutions, it is possible to achieve efficient radio communications without consuming power wastefully.~~These configurations enable radio communications at an excellent level of efficiency at minimum power.

A ~~transmission~~transmit power control method of the present invention has the steps of extracting transmit power control information from a packet signal comprised of transmission units each including the transmit power control information, determining quality deterioration of each of the packet signals, performing control for halting transmit power control on a transmission unit to be transmitted after determining the quality deterioration on the packet signal, based on a determined result, and performing the transmit power control on a beginning unit transmission portion of a next packet based on the transmit power control information for a transmission unit after determining the quality deterioration on the packet signal.

According to this method, ~~since~~ the power control is halted and the power control information is ~~only~~ stored

when ~~a~~ the quality of the packet signal deteriorates, ~~whereby~~ so that it is possible to ~~suppress~~ minimize wasteful power consumption by not increasing the transmit power. Furthermore, since transmission is not performed ~~with unreasonable~~ applying unreasonably high power ~~on~~ to a poor-quality communication channel, it is possible to reduce interference in ~~peripheral~~ nearby communication stations, increase the efficiency of ~~the~~ packet communication, and decrease ~~the total~~ overall transmit power, and achieve battery saving.

~~Furthermore, since~~ Further, the stored power control instruction information is reflected in a transmission unit of ~~a next pocket, it is possible to transmit the packet assuredly. Moreover~~ the next slot, thereby making possible secure packet transmission. Further, proper transmit power control can be performed ~~starting~~ from ~~a~~ the next packet signal~~. It is therefore~~ forward. This makes it possible to perform efficient ~~communications while decreasing~~ communication while reducing interference in ~~other stations.~~ the surroundings.

A transmit power control method of the present invention has the steps of extracting transmit power control information from packet signals each comprised of transmission units each including the transmit power control information, the packet signals being transmitted using a data channel and a control channel, determining

quality deterioration of each of the packet signals, performing control for halting transmit power control on a transmission unit to be transmitted after determining the quality deterioration on a packet signal for the data channel signal, based on a determined result, and performing the transmit power control on a beginning unit transmission portion of a next packet on the data channel, based on the transmit power control information for a last unit transmission portion in the packet signal on the control channel.~~—~~

According to ~~the~~ this method, on a poor-quality communication channel, ~~thus~~ controlling transmit power of ~~a~~ the pilot signal ~~portion~~ and the data signal ~~portion~~ separately ~~enables~~makes it possible to maintain accurate operation of the power control ~~to continue to operate accurately~~ and ~~further enables~~prevent transmission ~~not to be performed with unreasonable high~~applying excessive power. ~~It~~By this means, it is ~~thereby~~ possible to reduce interference in ~~peripheral~~nearby communication stations, increase the efficiency of packet communication, and perform more proper transmit power control upon next packet~~.~~ transmission.

In the transmit power control method of the present invention, it is preferable to determine the quality deterioration using the number of times the transmit power control information for increasing transmit power continues.

The present invention is not limited to the abovementioned embodiments, and is capable of being carried into practice with various modifications thereof. For example, while the above embodiments explain the case where as a method of determining quality deterioration, the method is used of counting the number of times the instruction for increasing transmit power continues, another method is applicable in the present invention as the method of determining quality deterioration. In other words, the method of determining quality deterioration is not limited to any particular one in the present invention.

As described above, the packet communication apparatus of the present invention is capable of performing power control adapted to packet communications, suppressing excessive power control for compensating for deterioration of communication path quality, and decreasing interfering power in peripheral communication stations and also total transmit power.

This application is based on the Japanese Patent Applications No.HEI11-156663 filed on June 3, 1999, and No.HEI11-188649 filed on July 2, 1999, entire contents of which are expressly incorporated by reference herein.

Industrial Applicability

The present invention is applicable to a base station apparatus and communication terminal apparatus in a

digital radio communication system.